ARIZONA DEPARTMENT OF WATER RESOURCES

PHOENIX AMA COMPREHENSIVE HYDROLOGIC MONITORING PLAN

THIRD ANNUAL STATUS REPORT

DECEMBER, 2004

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THIRD ANNUAL STATUS REPORT

PHOENIX AMA
COMPREHENSIVE HYDROLOGIC MONITORING PLAN
DECEMBER, 2004

PURPOSE

This status report provides the Phoenix Active Management Area (AMA) staff, the Groundwater Users Advisory Council (GUAC), and the general public with information on the progress made by the Hydrology Division during the third year of the Comprehensive Hydrologic Monitoring Plan for the Phoenix AMA.

This status report discusses the progress made between October 2003 and December 2004. It includes the following:

1. A list of monitoring tasks and accomplishments – 2003-2004.
   - Groundwater elevation data collection to include: a description of newly installed and operating groundwater monitoring sites, a description of proposed transducer site selection criteria and the installation and operation of a Domestic Satellite (DOMSAT) system
   - GPS and gravity data collection
   - Remote sensing and crop typing data collection
   - Total dissolved solids (TDS) and common ion data collection
   - Stream flow data collection

2. A list of cooperators having joined this project in 2003-2004.
   - Groundwater elevation data collection

3. A description of future work remaining.
   - Groundwater elevation data collection
   - GPS and gravity data collection
   - Remote sensing and crop typing data collection
   - Total dissolved solids (TDS) and common ion data collection
   - Database development
   - Stream flow data collection
   - Annual water budget
   - Internet website development

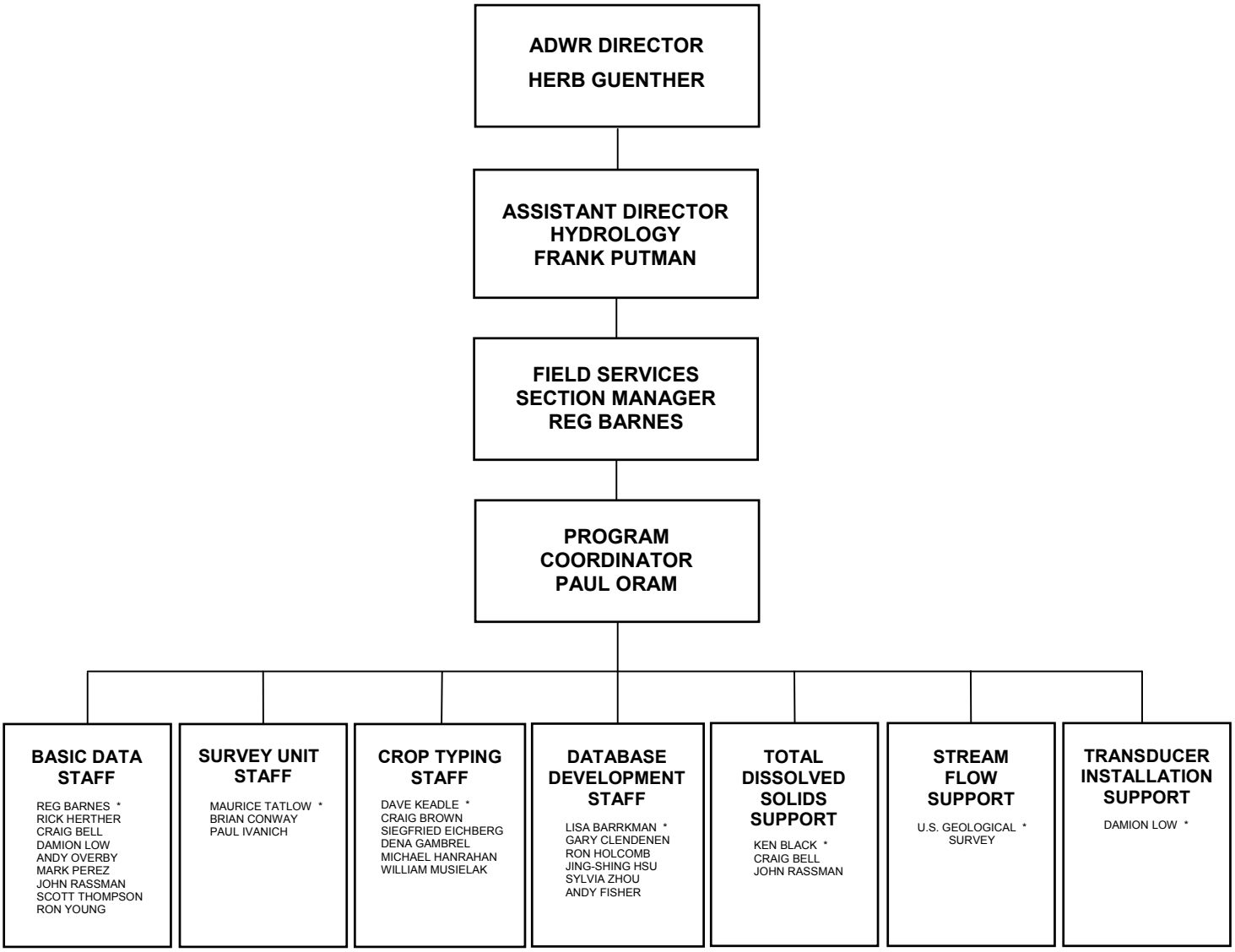
INTRODUCTION

The Arizona Department of Water Resources and its cooperators throughout the state have conducted groundwater-monitoring activities for many years. As part of the dialog with the Governor's Water Management Commission in 2001-2002, it became apparent a need existed for an increased level of monitoring of hydrologic conditions in the Phoenix AMA. Support for monitoring from the commission and funding from the Phoenix AMA Augmentation Fund affords the Department the opportunity to design and implement a comprehensive hydrologic monitoring program.

This program is not limited to the collection of groundwater data alone, but includes the collection of surface water data, subsidence data, gravimetric data and water use data. This will give the department the ability to construct timely and more accurate water budgets, and monitor the hydrologic behavior of the AMA more completely.

The comprehensive monitoring plan was originally designed to be implemented in three phases to allow the installation and monitoring work to be achieved with available staff and funding. The program has just completed its third year. Due to the shortage of available staff the installation phase of the Groundwater elevation data collection task will take more than the three years that was originally estimated. At the end of the installation phase, the system will be in place and maintenance will be an ongoing activity. The experience gained in the Phoenix AMA will be applied to the other AMAs enabling the Department to develop comprehensive monitoring plans in those areas of the state as well.

TASK RESPONSIBILITY CHART



** Indicates Team Leader*

Table 1. Task Responsibility Chart for Phoenix AMA Comprehensive Monitoring Plan

I. LIST OF MONITORING ACTIVITIES 2003 TO 2004

Activities for 2003-2004 (year three) were divided into specific tasks that could be performed by the various teams from the Field Services Section and other staff within the department. These tasks include groundwater elevation data collection, GPS and gravity data collection, remote sensing and crop typing data collection, total dissolved solids (TDS) data collection, stream flow data collection, database development and internet website development.

TASK ONE

GROUNDWATER ELEVATION DATA FROM INDEX WELLS, NEW MONITORING WELLS AND TRANSDUCERS

Introduction

Twenty-five wells have been added to the Phoenix water-level index program in Year Three bringing the total wells measured annually in the Phoenix AMA to 391. This will increase to the target number of 400 wells by the fourth year. New monitoring sites will be concentrated in developing areas of the AMA, in areas of high water-level change, where land subsidence is occurring, or in other areas of special interest. Revision of the index well network will include measuring more wells that represent specific aquifer units and the installation and use of up to 70 continuous recording, digital pressure transducers. Each year up to 20 transducers will be installed throughout the Phoenix AMA. Most transducer sites will be equipped with Geostationary Operational Environmental Satellite (GOES) data transmitters. Other transducer sites will have the data downloaded manually.

Because of the limited staff and an increasing workload, transducer installation is anticipated to occur in several phases, with each phase taking one year to complete. Experience in the Prescott and Santa Cruz AMAs has shown that 15 to 20 new transducer sites can be installed per year with existing staff.

Seven transducer sites were installed during Year Three. Other activities included reviewing and modifying current water-level index lines, locating wells, and obtaining letters of agreement for transducer sites. Years Four and Five will be similar in scope.

After Year Five the program will consist of maintaining the index lines and transducer sites and replacing faulty transducers systems as needed. Areas where water level information is critical will be evaluated each year beginning in Year Five and transducer sites may be installed in several of those areas as well.

Figure 1. Typical transducer site configured with satellite telemetry

Figure 2. Typical transducer site with low profile arrangement and no satellite telemetry

To date, 27 transducer sites have been installed and are in operation throughout the Phoenix AMA with seven new sites being added during Year Three. Twenty-five of these sites are transmitting data using satellite telemetry (See Figure 1). The remaining two sites are not equipped with satellite telemetry because of concerns about community aesthetics (See Figure 2). These sites were chosen based on several criteria discussed later in this report (See Appendix A, Page 28, and Appendix C, Map Plates). All transducers are recording date, time, and depth to groundwater, groundwater temperature, and system battery voltages every 6 hours. Some transducers will have the data collected manually and posted to ADWR's Groundwater Site Inventory (GWSI) database manually. Transducer data being transmitted via satellite uses the National Oceanic and Atmospheric Administration (NOAA) Geostationary Operational Environmental Satellite (GOES) System to send the data once per day. The telemetry data is acquired via the Local Readout Ground Station-Domestic Satellite (LRGS-DOMSAT) receiving system installed at the ADWR building in December of 2002. This system gives the Department the ability to receive the satellite transmitted water-level data directly from the field or queried through the (NOAA) Internet or Telnet web sites. The data is captured and uploaded into data tables where both manually downloaded and satellite transmitted data are posted daily. These data are made available to the public on ADWR's Field Services Website at www.water.az.gov/fieldservices.

Current Groundwater Data Collection Site Characteristics

Table 2 below briefly describes the installed groundwater data collection sites' characteristics and parameters. Figures 3 through 14 on pages 7 through 11 are images of the seven sites completed within the Phoenix AMA during the programs third year.

SITE CODE	WELL LOCATION	WELL OWNER	WELL ALTITUDE	WELL DEPTH	SATELLITE TELEMETRY	DATE COMPLETE
AA	D-02-07 22BBC	QUEEN CREEK	1403	606	YES	04/17/2002
AB	A-02-03 09CDA	ROSE LANE SCHOOL	1177	255	YES	04/19/2002
AC	B-04-05 01CBA	DOUGLAS LAND CORP.	1600	1000	YES	05/21/2002
AD	D-04-09 05AAD	BRIAN NICHOLS	1551	900	YES	06/06/2002
AE	A-03-01 04DBB	ARIZ. AMERICAN WATER	1192	910	YES	06/19/2002
AF	A-02-04 01ACC	CITY OF SCOTTSDALE	1298	1800	YES	07/30/2002
AG	A-05-05 05CAA	CITY OF SCOTTSDALE	2680	1505	NO	08/16/2002
AH	A-03-04 11CBA	CITY OF SCOTTSDALE	1448	1200	YES	09/11/2002
AI	A-02-02 28ABB2	CITY OF PHOENIX	1111	630	YES	10/02/2002
AJ	A-03-02 15DDD	CITY OF PHOENIX	1256	1585	YES	10/16/2002
AK	A-04-01 34BDD2	CITY OF PEORIA	1215	938	YES	02/28/2003
AL	A-04-01 14CBB	CITY OF PEORIA	1293	785	YES	03/18/2003
AM	A-01-06 15ACD	CITY OF MESA	1355	1204	YES	04/11/2003
AN	B-02-01 06ABB2	ADAMAN WATER CO.	1128	730	YES	04/20/2003
AO	B-02-02 13ABB	ADAMAN WATER CO.	1099	752	YES	04/23/2003
AP	A-01-05 29DDA	CITY OF MESA	1218	490	YES	05/12/2003
AQ	A-03-02 06DAA	CITY OF GLENDALE	1244	1003	YES	07/25/2003
AR	A-01-05 02DDC1	SALT RIVER PROJECT	1260	700	YES	08/07/2003
AS	C-01-04 06BBA	ROOSEVELT IRR. DIST.	915	1694	YES	09/20/2003
AT	D-01-05 15CDD2	SALT RIVER PROJECT	1218	660	YES	10/22/2003
AU	A-05-04 17BCD	CITY OF PHOENIX	1958	830	YES	02/25/2004
AV	A-03-02 34ADA	CITY OF PHOENIX	1213	1214	YES	06/10/2004
AW	A-02-04 25CDD	CITY OF SCOTTSDALE	1225	1200	YES	07/22/2004
AX	A-01-03 01ADA2	ARIZ. STATE LAND DEPT.	1155	160	YES	08/05/2004
AY	A-01-02 26AAA	UNITED METRO MAT'LS.	1042	430	YES	08/13/2004
AZ	C-01-06 12AAD	ARLINGTON EL. SCHOOL	905	420	YES	08/26/2004
BA	A-01-03 05ABD	PHOENIX ART SCHOOL	1087	400	NO	10/13/2004

Table 2. Groundwater-data collection site characteristics

Figure 3. City of Phoenix site "AU" located about ½ mile north of Lone Mountain Rd. on the east side of Cave Creek Rd.

Figure 4. City of Phoenix site "AV" located on the east side of 35th Drive about ¼ mile south of Dunlap Ave.

Figure 5. City of Scottsdale site "AW" located on the west side of Granite Reef Rd. about 1/8 mile north of Thomas Rd.

Figure 6. View of site "AW" showing transducer placed in an active well. Note: Transducer is housed in a dedicated tube beneath the red box.

Figure 7. Configuring the transducer at site "AW".

Figure 8. AZ. State Land Department site "AX" prior to site rehab. Site is located on the west side of 40th St. north of the 202 freeway.

Figure 9. Site "AX" shown after the construction of a new concrete pad.

Figure 10. Transducer site "AX" shown here after completion.

Figure 11. United Metro Materials site "AY" located on the south side of Buckeye Rd. west of 27th Ave.

Figure 12. Arlington Elementary School site "AZ" located in the southern part of the Hassayampa Sub-Basin.

Figure 13. Making a site assessment at the Phoenix Art Academy site "BA" prior to transducer installation.

Figure 14. Phoenix Art Academy site "BA" located near 2nd and Willetta Streets in downtown Phoenix. Site "BA" is a manual site with no satellite telemetry.

Transducer Well Site Selection Process

A Groundwater Site Inventory (GWSI) database query was developed to generate a list of unused and unequipped well sites throughout the Phoenix AMA as potential transducer candidates. Each well site was then visited and inventoried by Basic Data staff. If the well was unused and unequipped it received a database code, which enabled it to be pulled from the database and placed on a Geographic Information System (GIS) map. Each of these potential transducer sites went through a criteria selection process and evaluated as to water-level fluctuations, aquifer penetration, multiple aquifers completion, proximity to known subsidence zones, areas of major land development, proximity to groundwater recharge projects, and proximity to EPA Super Fund and WQARF sites (See Appendix A, Table 5, Page 29).

A letter of agreement was drafted following the Department of Administration's Risk Management guidelines and sent to the owners of the candidate sites along with an explanation of the monitoring program and a schematic diagram of the transducer site. To further expand the pool of potential transducer sites, the same information was sent to Phoenix AMA municipalities, irrigation districts and water companies. Those entities interested in the project in turn provided a list of candidate wells for ADWR to further evaluate (See Appendix B, Page 31).

(NOAA) GOES Satellite Account Authorization

Most of the transducer sites will be equipped with satellite telemetry. A formal GOES DCS (Data Collection System) Use Agreement between ADWR and NOAA was created through the NOAA NESDIS (National Environmental Satellite Data and Information Service). This contract is valid through the spring of 2007 and must be renewed every five years.

An initial request was made and filled in the program's first year for twenty DCP (Data Collection Platform) accounts that provide an identification number and time window for transmitting groundwater data through the GOES satellite system. During the second year NOAA approved a request for an additional 50 DCP accounts bringing the total number of NOAA accounts in the Phoenix AMA to 70.

Phoenix AMA Groundwater-Level Measurement Sweeps

Hassayampa Sub-basin

ADWR's Basic Data staff collected approximately 420 water levels in a basin wide sweep of the Hassayampa Sub-basin of the Phoenix AMA between October 2003 and April 2004. The sweep was performed in conjunction with a cooperative modeling effort between the Town of Buckeye, the Development Community and the Department in assessing the water resources of that area.

Phoenix AMA

ADWR's Basic Data staff collected approximately 1900 water levels in a basin-wide sweep of the Phoenix AMA between November 2002 and March 2003. The sweep was performed as part of the Monitoring program's overall effort in the assessment of an annualized groundwater budget. The water levels collected were used in conjunction with the Phoenix AMA Hydrologic Map Series (HMS) Report Number 35. This HMS report was produced in digital CD format and will be available to the public at the ADWR bookstore in March 2005. The report includes maps displaying well points with their corresponding water-level depths and water-level elevation values along with water-level elevation contours and groundwater flow direction arrows. A second map shows water-level changes in wells measured in 1997 and again in 2002 (See Appendix C, Map Plate 2). The Phoenix AMA HMS also includes water-level hydrographs illustrating historic water-level trends.

TASK TWO

LAND SUBSIDENCE AND AQUIFER STORAGE MONITORING

Introduction

Land subsidence is a well-documented effect of extensive groundwater depletion and has been studied in the Phoenix, Pinal, and Tucson AMAs, as well as many other areas of the United States. Monitoring of specific areas of subsidence through Global Positioning System (GPS) surveys of land elevation changes and gravimetric measurements of changes in water stored in the aquifer may allow the Department to design appropriate management programs to deal with these issues. Potential affects of subsidence include changes in drainage characteristics, infrastructure damage, and loss of aquifer storage capacity. Interferometric Synthetic Aperture Radar (InSAR) is also being used to better map and understand subsidence patterns throughout the Phoenix AMA (See Figure 15, Page 15).

The Surveying Unit of the Field Services Section of ADWR is performing aquifer storage monitoring (gravity surveys) and land subsidence monitoring (GPS surveys) surveys within the Phoenix AMA.

In addition to performing gravity and GPS surveys the Surveying Unit is partnering with other groups that have interest in monitoring land subsidence, fissure formation and development, and aquifer storage change. These groups include the Flood Control District of Maricopa County, the Maricopa County Department of Transportation (MCDOT), The Central Arizona Project (CAP), the City of Scottsdale, the National Geodetic Survey (NGS), Arizona State University (ASU), and the National Aeronautics and Space Agency (NASA) Center for

Space Imaging. Working with these groups allows ADWR to maximize the benefit of its monitoring efforts and minimize costs.

Work and Projects in 2003-2004

Phoenix AMA Aquifer Storage Monitoring Network: The Surveying Unit performed the third set of gravity occupations of aquifer monitoring stations from March 2004 through May 2004. This included occupations of the three Toyota Test Track stations.

Pool 23-24 ADWR/CAP project: This project is on-going from 2003. CAP has retained GEOTrans as consultant to continue an on-going, expanded investigation of this area in 2004 that includes the CAP Pool 23 and Pool 24 areas.

Field Services Transducer surveys: In 2004 the unit began static GPS surveys providing the Department with survey-grade locations for all Phoenix AMA transducer well sites as a part of the Phoenix AMA Comprehensive Monitoring Program.

Absolute Gravity Surveys: Support is ongoing for NGS absolute gravity measurements at stations PHX AA (in South Mountain Park), PHX AB (in Dreamy Draw Park), PHX AC (at Usery Mountain AT&T facility), and CENTRAL ARIZONA COLLEGE.

Interferometric Synthetic Aperture Radar (InSAR): The Department is continuing to generate InSAR products (interferograms, deformation profiles, and XYZ raster files) within the Phoenix AMA through the 1.3 million dollar NASA BAA grant. A partial list of end users include the Flood Control District of Maricopa County, Central Arizona Project, City of Peoria, City of Scottsdale, Salt River Project, NRCS, AMEC, Geological Consultants, Arcadis, GeoTrans, HydroGeophysics, and Clear Creek Associates.

Hassayampa Gravity and GPS Survey: Over 1300 gravity and GPS stations were established between May and September 2004 to support a cooperative groundwater modeling effort and the Departments Assured Water Supply program in the Lower Hassayampa Sub-basin. This involved performing relative gravity surveys throughout the sub-basin for the purpose of depth-to-bedrock interpretations as well as more clearly defining the shallow subsurface lithology. GPS surveys were required to establish the location and elevation of all stations used in the gravity survey. The surveys were completed in September of 2004. Publication of the results is expected in the spring of 2005.

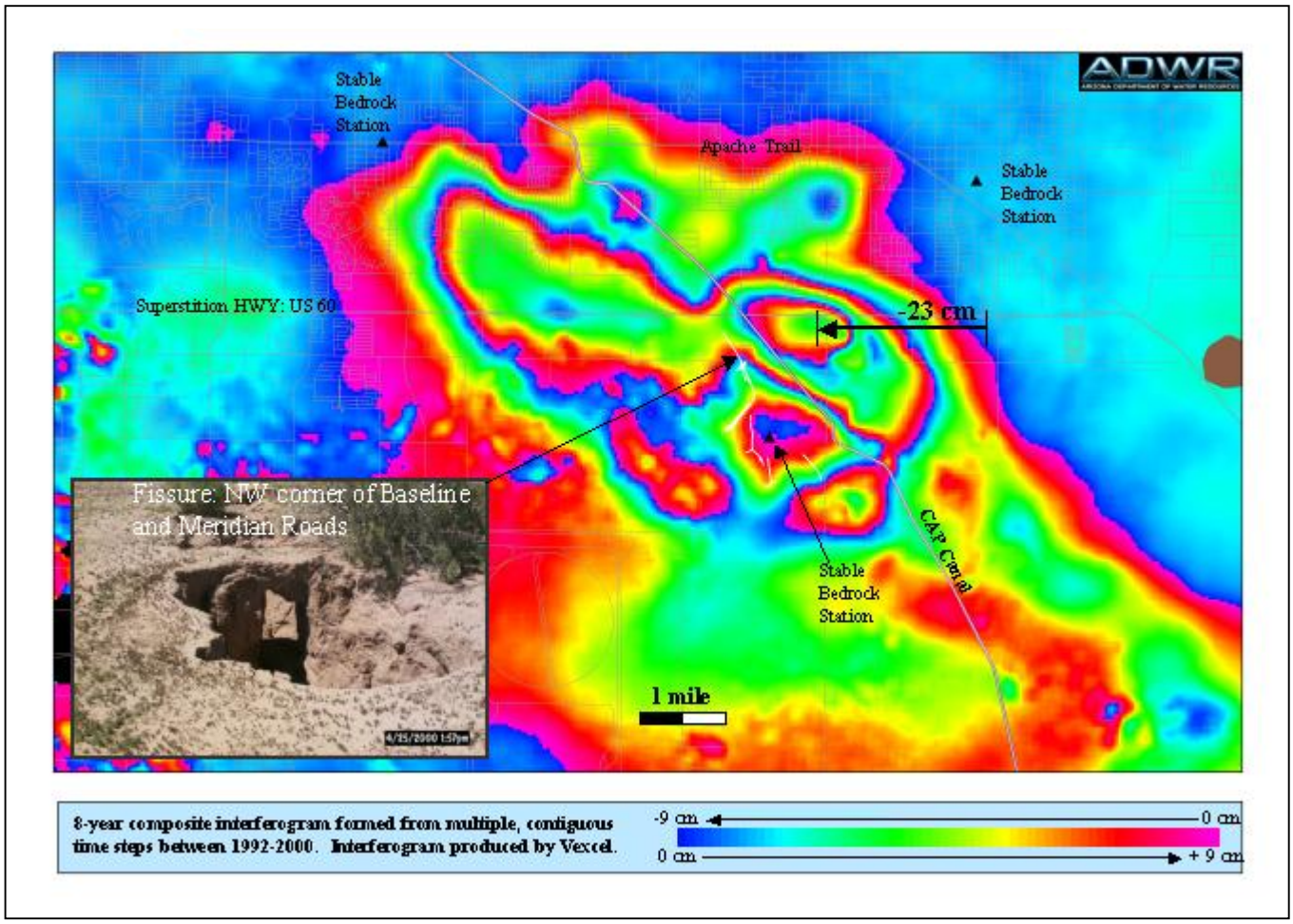


Figure 15. Composite Interferogram: 1992-2000, East Salt River Valley. Each concentric color ring shows land subsidence of about 9 cm. (3 ½ inches) over and eight year period. The maximum eight-year land subsidence is about 23 cm. (9 inches).

TASK THREE

CROP TYPE AND ACREAGE DETERMINATION

Introduction

The Department has implemented a remote sensing program to facilitate the acquisition of agricultural data to allow more accurate estimates of water use and recharge. In the Phoenix AMA, the acquired data includes the number of acres in agricultural production and the type of crops grown. The data will eventually aid in analyzing agricultural water use and recharge in order to improve the accuracy of the AMA's water budget.

Work and Projects Ongoing in 2003-2004

ADWR is continuing to work with remote sensing specialists from the US Bureau of Reclamation to implement the Lower Colorado River Accounting System (LCRAS) methodology in the Phoenix AMA.

High-resolution color satellite imagery was used to delineate agricultural fields and boundaries. The fields were digitized, given unique identification numbers, and stored in a database. Landsat 5 and Landsat 7 satellite images were used to discriminate between crop groups and agricultural land use. This process utilizes ERDAS's IMAGINE® software in classifying crops using the reflective value of each digital pixel, or signature.

Part of the process involves field verifying approximately 15 percent of the agricultural fields in the AMA. The field verification or ground truthing is scheduled in conjunction with satellite passes. The ground reference data is used in the image classification process to improve accuracy. Optimally, imagery processing and ground truthing will take place two to three times per year in order to capture the seasonal variation of all agricultural land use. The seasonal timing of each analysis is dependant on the nature of crops grown in the AMA. Plate 5 in Appendix C shows fields that were visited for ground truthing purposes.

Table 3 on page 17 shows a listing of crop types and corresponding acreages accessed in April and again in June 2004 using both satellite imagery and ground truthing. The data will be utilized in determining new water budgets and updating hydrologic models. A significant result of this work was the realization that the currently irrigated acreage is considerably less than the Department's groundwater model for the Salt River Valley has assumed would be in place in 2004.

TASK FOUR

WATER QUALITY MONITORING

Introduction

ADWR has broad water-quality concerns related to the suitability of water for various use sectors. There have been concerns expressed that importation, use and subsequent recharge of CAP water may add to the accumulated salt load in the aquifer over time. This is one example of how the overall quality of water may affect its utilization.

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CROP TYPE	APRIL 2004 ACRES	PERCENTAGE OF TOTAL ACRES	JUNE 2004 ACRES	PERCENTAGE OF TOTAL ACRES
ALFALFA	62,701	32%	51,106	26%
BERMUDA GRASS	518	<1%	569	<1%
CITRUS	2,722	1%	2,862	1%
CORN	1,450	<1%	4,615	2%
COTTON	N/A	N/A	41,409	21%
CRUCIFERS	270	<1%	N/A	N/A
DATES	100	<1%	N/A	N/A
DECIDUOUS ORCHARDS	627	<1%	467	<1%
FALLOW [1]	103,097	52%	84,679	42%
GRAPES	108	<1%	108	<1%
LEGUME/SOLANUM VEGETABLES	1,631	<1%	2	<1%
MELONS	N/A	N/A	314	<1%
ROSES	620	<1%	566	<1%
SMALL GRAINS	19,575	10%	2,179	1%
SMALL VEGETABLES	1,651	<1%	N/A	N/A
SUDAN GRASS	2,154	1%	825	<1%
TOTAL IRRIGATED ACREAGE [2]	197,225		189,699	
TOTAL NUMBER OF FIELDS	6,063		6,004	
ACREAGE SAMPLED [3]	44,508		51,538	
TOTAL DATABASE ACRES [2]	198,730		199,338	
OVERALL ACCURACY	94%		92%	

NOTES:

1. Fallow is used in this table to mean a field on which a crop is not currently being grown.
2. Total Database Acres is the acreage within the ADWR field boundary database originally developed from satellite images above. When field surveys take place some of the Total Database Acres are found to be developed or to consist of native vegetation, non-irrigated pasture, or non-agricultural uses, or to have other uses such as greenhouses, which are not considered to be irrigated agriculture. These uses are subtracted from the Total Database Acreage to give Total Irrigated Acreage. The Totals have trended downward because of urban development.
3. Field staff visited 15% of the fields to verify crop type. A small number of fields from the 15% field survey were not used because they were found to be developed or to consist of native vegetation, non-Ag pasture, greenhouses or unknown use.

Table 3. Crop types and acreage of fields accessed April and June 2004

the aquifer over time. This is one example of how the overall quality of water may affect its utilization.

The USGS and ADWR have collected thousands of specific conductance samples over the years, and this approach has been expanded to allow a broad view of water-quality conditions by very inexpensive means. Specific conductance is a field measurement that is closely related to the total dissolved solids (TDS) content of water.

TDS is a broad measurement of the salt load of water. The Department no longer collects other basic information on groundwater quality on a regional scale from the water quality index wells due to budget cuts. Between 50 and 100 wells will be randomly sampled for specific conductance per year over the entire AMA and occasional sampling of the flows in the Salt and Gila Rivers will be conducted to monitor TDS levels in the groundwater and surface waters of the AMA.

Work and Projects Performed in 2003-2004

The GWSI database was queried to determine which wells were previously sampled by the USGS and ADWR. These previously sampled wells were targeted first to provide chronological water-quality data. Wells with close proximity to recharge projects, CAP recharge areas, or large groundwater irrigators within the Phoenix AMA were also sampled.

An annual TDS index line is being established to collect water-quality data within the Phoenix AMA. Due to Department staff shortages no wells were sampled for TDS during the second year 2002-2003, however, water providers were contacted to determine what existing TDS data they have available and their data is being analyzed to determine where additional wells may be sampled. Consequently eighty-two wells were sampled during 2003-2004 (See Table 4, Pages 19-20 and Appendix C, Map Plate 4). This new TDS data will be incorporated into ADWR's GWSI database.

LOCAL ID	WATER USE	DATE SAMPLED	SP. COND µS/Cm	TDS * Mg/L
A-01-01 09BBB2	IRRIGATION	10/5/2004	2950	1770
A-01-01 19ABB	IRRIGATION	10/5/2004	3340	2004
A-01-01 21DDA3	IRRIGATION	9/28/2004	2980	1788
A-01-02 20DDC	INDUSTRIAL	7/29/2004	1702	1021
A-01-02 31AAA	IRRIGATION	9/28/2004	2880	1728
A-01-04 01ABA1	IRRIGATION	7/20/2004	1283	770
A-01-05 01ADD	IRRIGATION	8/19/2004	1195	717
A-01-05 02CBB2	IRRIGATION	8/19/2004	1051	631
A-01-05 02CDD2	IRRIGATION	8/31/2004	1337	802
A-01-05 03DDC	IRRIGATION	8/31/2004	1198	719
A-01-05 04DDD2	IRRIGATION	8/31/2004	1129	677
A-01-05 10CCC	IRRIGATION	8/31/2004	1068	641
A-01-05 11CAC	IRRIGATION	8/19/2004	1578	947
A-01-05 13BBC	IRRIGATION	8/19/2004	1749	1049
A-01-05 14BAA	IRRIGATION	8/19/2004	1307	784
A-01-05 24AAD	IRRIGATION	8/31/2004	2060	1236
A-01-05 26DDD	IRRIGATION	8/31/2004	3040	1824
A-01-05 33CDD	IRRIGATION	8/26/2004	2070	1242
A-01-06 06BBC	IRRIGATION	8/19/2004	1000	600
A-01-06 07ABB2	IRRIGATION	8/19/2004	1166	700
A-01-06 17ACC	IRRIGATION	8/19/2004	1792	1075
A-01-06 21CDC	IRRIGATION	8/19/2004	1411	847
A-01-06 28DDC2	IRRIGATION	8/19/2004	1905	1143
A-01-06 32BBA2	IRRIGATION	8/19/2004	2002	1201
A-01-06 34CCD	IRRIGATION	8/19/2004	1407	844
A-02-01 14BBA	IRRIGATION	10/6/2004	1369	821
A-02-01 14CCC	IRRIGATION	10/6/2004	1586	952
A-02-01 15ABB	IRRIGATION	10/6/2004	1601	961
A-02-01 17DDD2	IRRIGATION	10/6/2004	1526	916
A-02-01 20DAA	IRRIGATION	10/6/2004	1721	1033
A-02-01 20DDD2	IRRIGATION	10/6/2004	1688	1013
A-02-01 23DDA	IRRIGATION	10/6/2004	1735	1041
A-02-01 28AAA1	IRRIGATION	10/6/2004	1875	1125
A-02-01 29DDD2	IRRIGATION	10/6/2004	1862	1117
A-02-01 36DAD	IRRIGATION	10/6/2004	2060	1236
A-02-03 07DCC2	IRRIGATION	9/2/2004	1366	820
A-02-03 20ADD2	IRRIGATION	9/2/2004	1851	1111
A-02-03 21DAA2	IRRIGATION	9/2/2004	2170	1302
A-02-03 24ADA	IRRIGATION	9/2/2004	1995	1197
A-02-03 25BBB2	IRRIGATION	9/2/2004	1777	1066
A-02-04 11DCC2	IRRIGATION	9/3/2004	599	359
A-02-04 12ADD2	IRRIGATION	9/2/2004	1048	629
A-02-04 12BDA2	IRRIGATION	9/2/2004	853	512
A-02-04 22DCC	IRRIGATION	9/2/2004	1841	1105
A-02-04 24BAD	IRRIGATION	9/3/2004	1446	868
A-02-04 25BCD	IRRIGATION	9/3/2004	1713	1028
A-02-04 30ADD	IRRIGATION	9/3/2004	1591	955
A-02-06 27CAB	IRRIGATION	9/3/2004	1118	671
A-02-06 27CBC	IRRIGATION	9/3/2004	1218	731

Table 4. Specific Conductance and TDS values from wells sampled in 2004 (continued on next page).

LOCAL ID	WATER USE	DATE SAMPLED	SP. COND µS/Cm	TDS * Mg/L
A-02-06 28DDB	IRRIGATION	9/3/2004	1142	685
A-03-01 24CBB	IRRIGATION	10/19/2004	1089	653
A-03-01 35ABB	IRRIGATION	10/19/2004	1411	847
A-03-01 35DDD	IRRIGATION	10/19/2004	1438	863
A-03-02 21DBB	PUBLIC SUPPLY	10/20/2004	1234	740
B-01-01 28ADA2	IRRIGATION	7/20/2004	3460	2076
B-01-01 28CDC	IRRIGATION	7/20/2004	4320	2592
B-01-01 29DDA2	IRRIGATION	7/20/2004	3960	2376
B-01-01 30CBA	IRRIGATION	7/20/2004	4790	2874
C-01-03 06BCB	IRRIGATION	7/27/2004	5250	3150
C-01-03 06BDB	IRRIGATION	7/27/2004	4890	2934
C-01-04 01BCC	IRRIGATION	7/27/2004	5680	3408
C-01-04 01BDD1	IRRIGATION	7/27/2004	5250	3150
C-01-04 02DBB2	IRRIGATION	7/27/2004	5600	3360
D-01-03 06AAA	IRRIGATION	7/26/2004	2220	1332
D-01-04 03BBB2	IRRIGATION	8/26/2004	2000	1200
D-01-04 10BDD1	IRRIGATION	7/27/2004	1431	859
D-01-04 11BCC	IRRIGATION	8/26/2004	1856	1114
D-01-05 01BAB	IRRIGATION	8/26/2004	1622	973
D-01-05 03CCC2	IRRIGATION	6/16/2004	1322	793
D-01-05 03DDD2	IRRIGATION	6/16/2004	1617	970
D-01-05 08ACC	IRRIGATION	7/2/2004	1390	834
D-01-05 09DBB	IRRIGATION	7/2/2004	1401	841
D-01-05 10DDD2	IRRIGATION	8/26/2004	2580	1548
D-01-05 12CCC	IRRIGATION	7/2/2004	1432	859
D-01-05 21BDC	IRRIGATION	8/26/2004	1474	884
D-01-05 22CCC2	IRRIGATION	8/26/2004	2770	1662
D-01-05 24CDC	IRRIGATION	8/26/2004	2220	1332
D-01-06 15BAB	PUBLIC SUPPLY	6/16/2004	1344	806
D-01-06 21AAA	IRRIGATION	7/1/2004	1483	890
D-02-05 02BDD	IRRIGATION	8/26/2004	2070	1242
D-02-05 04ADD	IRRIGATION	7/2/2004	1476	886
D-02-05 11CCC	IRRIGATION	7/2/2004	1777	1066

* The Total Dissolved Solids (TDS) level is only an approximation. A general conversion factor of 0.6 was used to convert specific conductance values from microSiemens per centimeter (µS/Cm) to TDS levels in milligrams per liter (mg/L). The actual conversion factor will vary depending on the water quality specific to each well.

Table 4. Specific Conductance and TDS values from wells sampled in 2004 (continued from previous page).

TASK FIVE

GWSI FIELD DATABASE

A crucial part of the monitoring program is the ability to interact with the Department's groundwater database and manipulate data while in the field. The Information Technology Division (ITD) and Hydrology Division have designed and implemented a field-interactive database application allowing Field Services personnel to enter field-collected data directly into the Department's Groundwater Site Inventory (GWSI) database. The new application has eliminated the need for transcribing data from field forms to coding sheets before the data is input into the GWSI. The new system has effectively cut two steps out of the transcription process greatly reducing errors and office time associated with transcribing data. This new field data input system was implemented during the winter of 2002-2003 and is now being field-tested and improvements are being implemented as needed. The application also provides an area for storage of photos, GPS data, and digitized maps in jpeg picture format that can be used for navigation and well locating. Text messages can be also stored here as jpeg images.

TASK SIX

STREAM FLOW RECHARGE

The US Geological Survey (USGS) was enlisted under the ADWR/USGS cooperative agreement to construct and operate new stream-gaging stations in the Phoenix AMA. After conferring with the USGS, it was determined that two stations would be constructed and placed into operation during the plan's first year (See Appendix C, Plate 1). These two new stations will help bolster the more than 100 stream-gaging stations already in place within the Phoenix AMA. The Maricopa County Flood Control District and the USGS operate these gage sites in cooperation with ADWR, Salt River Project (SRP) and other agencies.

The two stream-gaging stations were completed during Year One and are currently in operation. One stream-gage is located at the 51st Ave. bridge crossing on the Salt River in Phoenix (See Figure 16, Page 21). The USGS identifying number is 09512406 and real-time data for this site can be found at the USGS Internet web address http://waterdata.usgs.gov/az/nwis/uv?09512406. The second stream-gaging site is located at the Attaway Rd. bridge crossing on the Gila River in Pinal county just south of the Phoenix AMA (See Figure 17, Page 21). The USGS identifying number for this site is 09477570 and real-time data can be found at the USGS Internet web address http://waterdata.usgs.gov/az/nwis/uv?09477570. The two stations are equipped with pressure transducers and data loggers to record data and are radio equipped for real-time data transmission using the GOES domestic satellite transmission system (See data on Figures 18 and 19, Page 22).

Figure 16. USGS/ADWR stream-gage #09512406 located at 51st Ave. and the Salt River.

Figure 17. USGS/ADWR stream-gage #09477570 located at Attaway Rd. and the Gila River.

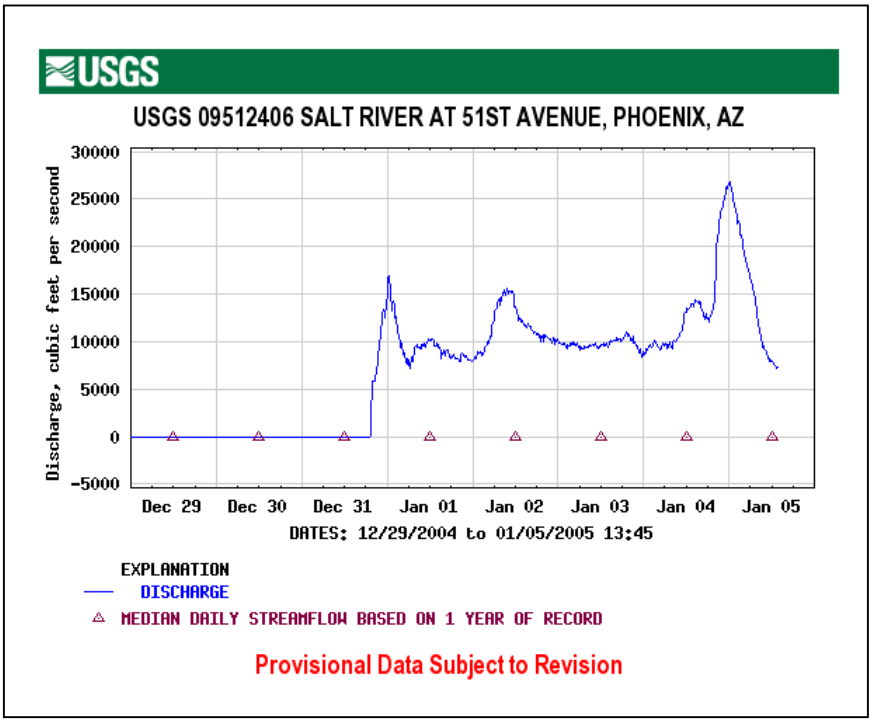


Figure 18. Discharge in cubic feet per second in the Salt River at the 51st Ave. gaging station.

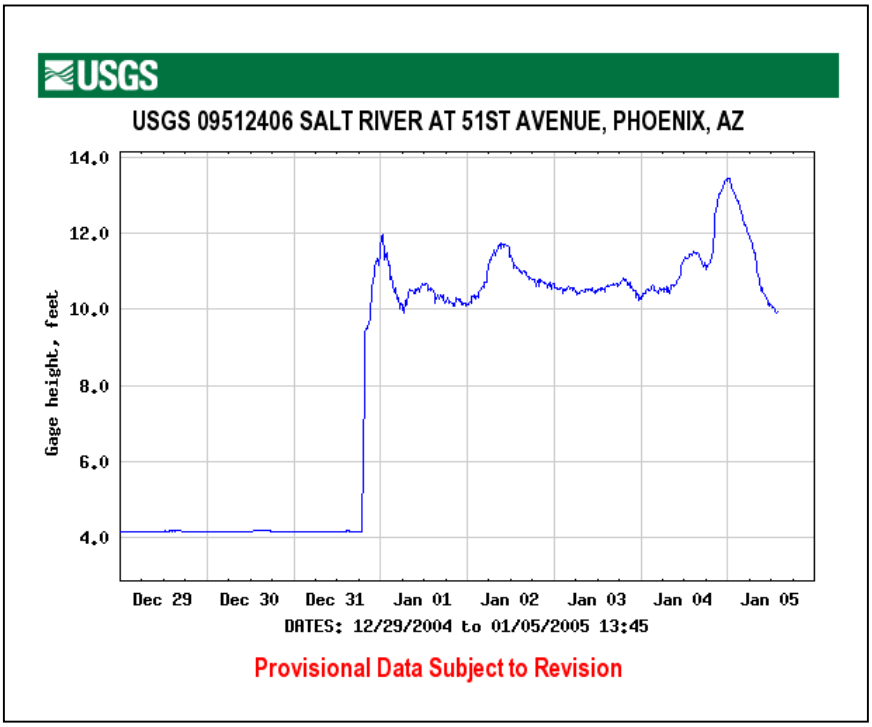


Figure 19. Gage height in feet in the Salt River at the 51st. Ave. gaging station.

II. FUTURE WORK AND PLANNING

Groundwater-Level Data Collection

- Install about 10 pressure transducers in wells per year. ADWR will continue to install pressure transducers for groundwater data collection systems throughout the Phoenix AMA using the current well selection criteria outlined in Appendix A. The installation schedule has been scaled down due to staff shortages and competing priorities.
- Continue to locate critical areas within the Phoenix AMA where groundwater data collection is essential but no existing well sites are available. These locations will become candidate monitoring well installation sites.
- Investigate and locate new transducer well site candidates throughout the Phoenix AMA and solicit participation from new entities and acquire signed letters of agreement for transducer installation.
- Continue to operate and maintain current transducer well sites. Continue to periodically download field data from transducer sites and input into ADWR's Groundwater Site Inventory database.
- Continue to evaluate the Phoenix AMA water-level index lines. There are currently 391 wells in nine books throughout the AMA. The water-level index

program will be evaluated and revised as needed to keep about 400 wells in the system that will be measured annually. Wells that have been abandoned or where the access is impaired will be replaced.

- Prepare a Phoenix AMA, Hydrologic Map Series Report (HMS) in conjunction with the Phoenix AMA basin wide water-level sweep that was completed during the winter of 2002-2003. The HMS report will be produced in digital CD format and made available to the public at the ADWR bookstore in 2004. This report will include a map displaying well points with corresponding water levels and water-level elevation values along with water-level elevation contours and groundwater flow direction arrows. A second map will show water-level changes in wells measured in 1997 and again in 2002. The Phoenix AMA HMS will also include water-level hydrographs illustrating historic water-level changes.

GPS/GRAVITY Projects

- Phoenix AMA Aquifer Monitoring Network: The GPS/Gravity group plans to perform the fourth set of gravity occupations in March, April and May of 2005. This includes occupations of the three Toyota Test Track stations along with static GPS survey of all stations.
- Pool 23-24 ADWR/CAP: This project is on going. ADWR continues to support this investigation by generating new interferograms of the area and providing these products to all interested parties as well as helping with GPS monitoring.
- Hawk Rock GPS survey: The Survey group plans to perform a sixth survey of this network in January 2005. Results from this survey will be used to ground truth InSAR results as well as provide insight into the continued deformation occurring in this area.
- Water Quality Assurance Revolving Fund projects: The Survey group will begin surveying the West Van Buren WQARF site in February 2005 surveying approximately 1100 wells by March or April.
- Field Services Transducer surveys: The Survey unit will continue to survey transducer locations for the Field Services section. This work was begun in 2004 and is an ongoing project as transducers are installed and sites become available for survey.
- Ablsolute Gravity Surveys: There is continued support of NGS absolute gravity measurements at stations PHX AA (in South Mountain Park), PHX AB (in Dreamy Draw Park), PHX AC (Usery Mountain AT&T facility), and CENTRAL ARIZONA COLLEGE. If funds are available at least one occupation of these stations is planned in 2005.
- Interferometric Synthetic Aperture Radar (InSAR): The Department will continuing to generate InSAR products (interferograms, deformation profiles, and XYZ raster files) within the Phoenix AMA through the 1.3 million dollar NASA BAA grant. In 2005 the project will also involve ground truthing with GPS surveys. This grand will end in 2005 and the Department is seeking cooperation to continue acquisition and analysis of InSAR images.

- Hassayampa Gravity and GPS Survey: Over 1300 gravity and GPS stations were established between May and September 2004 to support a groundwater modeling effort in the Lower Hassayampa Sub basin. This involved performing relative gravity surveys throughout the sub basin for the purpose of depth-to-bedrock interpretations as well as more clearly defining the shallow subsurface lithology. GPS surveys were required to establish the location and elevation of all stations used in the gravity survey. The surveys were completed in September of 2004. Interpretation of the data will be completed in January 2005.

Remote Sensing and Crop-Typing

- LandSat image processing and ground truthing will take place in April and June in 2005 in order to capture seasonal crop variations and to determine when agricultural land goes in and out of production. Again this year approximately 15% of the AMA's total agricultural acreage will be field verified and a summary of the Phoenix AMA's cropped acreage will appear in next year's Monitoring Program Status Report

Water Quality Monitoring and Collection

- ADWR's Field Services staff will collect approximately 50 new Total Dissolved Solids (TDS) samples and continue to contact water providers to obtain their TDS data when available in the continuing effort to build an annual TDS index line. After the four-year setup phase the Department will have sampled enough wells to determine in which areas of the AMA wells should be sampled annually. The creation of this yearly TDS monitoring line will help determine the affect that salt loading has on how the AMA's groundwater is utilized.

Stream Flow Data Collection

- ADWR in cooperation with the USGS will continue to monitor the data from the two new stream gages installed on the Salt and Gila Rivers in 2002. In addition ADWR will utilize this data along with that of other stream gages throughout the Phoenix AMA to help formulate a more accurate water budget.

Database And Website Development

- The Hydrology Division and the Information Technology Division (ITD) staff will continue the combined effort to field test and improve the field-interactive database utility that was completed and implemented in 2002. The ITD staff will continue to improve the ADWR Field Services Internet website. This site allows Internet users to query both real-time and historic transducer acquired water-level data within the Phoenix AMA. These data are currently available at the ADWR Internet web address www.water.az.gov/fieldservices/.

Updates to the website will be implemented when new web technologies become available.

Annual Status Report

- ADWR will produce a comprehensive and detailed 4th Annual Status Report using the data collected and evaluated during the fourth year of this monitoring plan. These data will be used by the Hydrology Division to produce more accurate and more complete annualized water budgets for the Phoenix AMA and to improve groundwater modeling efforts.

APPENDIX A

DESCRIPTION OF TRANSDUCER SELECTION CRITERIA

DESCRIPTION OF TRANSDUCER SITE SELECTION CRITERIA

The Phoenix AMA transducer locations are based on a set of criteria to achieve the best overall spatial coverage in two- and three-dimensional parameters, and in key groundwater areas throughout the AMA. The criteria are as follows:

1. Well casing perforated in upper, middle or lower aquifer units (See Second Annual Status Reports, Appendix C, Plates 2, 3, & 4).
2. Proximity to a major stream channels (See this report, Appendix C, Plate 1).
3. Large water-level changes occurring within a five-year period (See this report, Appendix C, Plate 2; For more detailed water-level changes See ADWR Hydrologic Map Series Report No. 35, Maps Showing Goundwater Conditions in the Phoenix AMA – Nov. 2002-Feb. 2003, Water Level Change Map Sheet 2 0f 2).
4. Municipalities that have provided transducer candidate sites (See Second Annual Status Reports, Appendix C, Plate 7).
5. Proximity to a known subsidence zone (See this Report, Appendix C, Plate 3).
6. Proximity to a recharge project or recharge zone (See Second Annual Status Report, Appendix C, Plate 9).
7. Irrigation companies that have provided transducer candidate sites (See Second Annual Status Report, Appendix C, Plate 10).
8. Proximity to EPA Superfund or WQARF sites (See Second Annual Status Report, Appendix C, Plate 11).
9. Areas of anticipated development or urbanization.

SITE	PERFORATED IN UPPER AQUIFER	PERFORATED IN MIDDLE AQUIFER	PERFORATED IN LOWER AQUIFER	CLOSE TO WATER COURSES	WATER LEVEL CHANGE LAST 5 YEARS	WITHIN A MUNICI-PALITY	WITHIN OR NEAR A SUBSIDENCE ZONE	NEAR A RECHARGE AREA	WITHIN AN IRR. DISTRICT	WITHIN OF NEAR A WQARF SITE	WITHIN OR NEAR A SUPER FUND SITE
AA	YES	YES	NO	YES	UP	YES	NO	YES	YES	NO	NEAR
AB	YES	NO	NO	YES	UP	YES	NO	YES	YES	NO	NEAR
AC	NO	YES	NO	NO	UP	NO	NO	NO	NO	NO	NO
AD	UNKNOWN	UNKNOWN	UNKNOWN	NO	UP	NO	NO	NO	YES	NO	NO
AE	YES	YES	NO	YES	DOWN	YES	WITHIN	YES	NO	NO	NO
AF	NO	NO	YES	YES	DOWN	YES	NEAR	YES	NO	NO	NEAR
AG	NO	NO	YES	NO	DOWN	YES	NO	YES	NO	NO	NO
AH	YES	YES	YES	NO	UP	YES	WITHIN	YES	NO	NO	NO
AI	YES	YES	NO	NO	DOWN	YES	NO	NO	YES	YES	NEAR
AJ	YES	YES	YES	YES	UP	YES	NEAR	NO	NO	NO	NO
AK	YES	YES	NO	YES	DOWN	YES	YES	YES	NO	NO	NO
AL	NO	NO	YES	YES	DOWN	YES	NEAR	YES	NO	NO	NO
AM	NO	YES	YES	NO	UP	YES	NO	YES	NO	NO	NO
AN	YES	YES	NO	NO	DOWN	NO	NEAR	NO	YES	NEAR	NEAR
AO	YES	YES	NO	NO	UP	NO	NEAR	NO	YES	YES	NEAR
AP	YES	YES	NO	YES	DOWN	YES	NO	YES	YES	NEAR	NEAR
AQ	UNKNOWN	UNKNOWN	UNKNOWN	YES	UP	YES	NEAR	NO	NO	NO	NO
AR	YES	YES	NO	YES	UP	YES	NO	YES	YES	NO	NO
AS	NO	YES	YES	YES	DOWN	NO	NO	NO	YES	NEAR	NEAR
AT	YES	YES	NO	NO	DOWN	YES	NO	YES	YES	NEAR	NEAR
AU	NO	NO	YES	NO	DOWN	YES	NO	NO	NO	NO	NO
AV	NO	YES	YES	NO	DOWN	YES	NO	NO	YES	NO	NO
AW	YES	YES	YES	NO	DOWN	YES	NO	NO	YES	YES	YES
AX	UNKNOWN	UNKNOWN	UNKNOWN	YES	DOWN	YES	NO	NO	YES	YES	YES
AY	YES	YES	NO	YES	DOWN	YES	NO	NO	YES	NEAR	NO
AZ	UNKNOWN	UNKNOWN	UNKNOWN	YES	UNKNOWN	NO	NO	NO	NO	NO	NO
BA	YES	YES	NO	NO	YES	YES	NO	NO	YES	YES	YES

Table 5. Current Transducer Sites with Applicable Selection Criteria
See Appendix C for Map Plates Showing Transducer Site Placement

APPENDIX B

PHOENIX AMA MONITORING PLAN COOPERATORS

COOPERATORS IN ADWR'S GROUNDWATER ELEVATION DATA COLLECTION TASK

The following is a list of participants that have signed ADWR's letter of agreement for joint-use of their well site(s) for the purpose of installing transducer, data logger, and telemetry equipment, for water level monitoring.

Cooperator	Date Signed
1. Arizona-American Water Company	March 18, 2002
2. Queen Creek Water Company	March 27, 2002
3. Rose Lane Elementary School	April 8, 2002
4. Douglas Land Corp. L.L.C.	April 22, 2002
5. Brian Nichols	May 5, 2002
6. City of Scottsdale	May 17, 2002
7. City of Phoenix	August 29, 2002
8. City of Peoria	December 2, 2002
9. City of Mesa	March 20, 2003
10. Adaman Water Company	April 1, 2003
11. Salt River Project	June 3, 2003
12. City of Glendale	June 17, 2003
13. Roosevelt Irrigation Company	June 30, 2003
14. AZ State Land Department	July 2, 2004
15. United Metro Materials	August 4, 2004
16. Arlington School	August 9, 2004
17. Sundown Properties, Ltd.	September 12, 2004

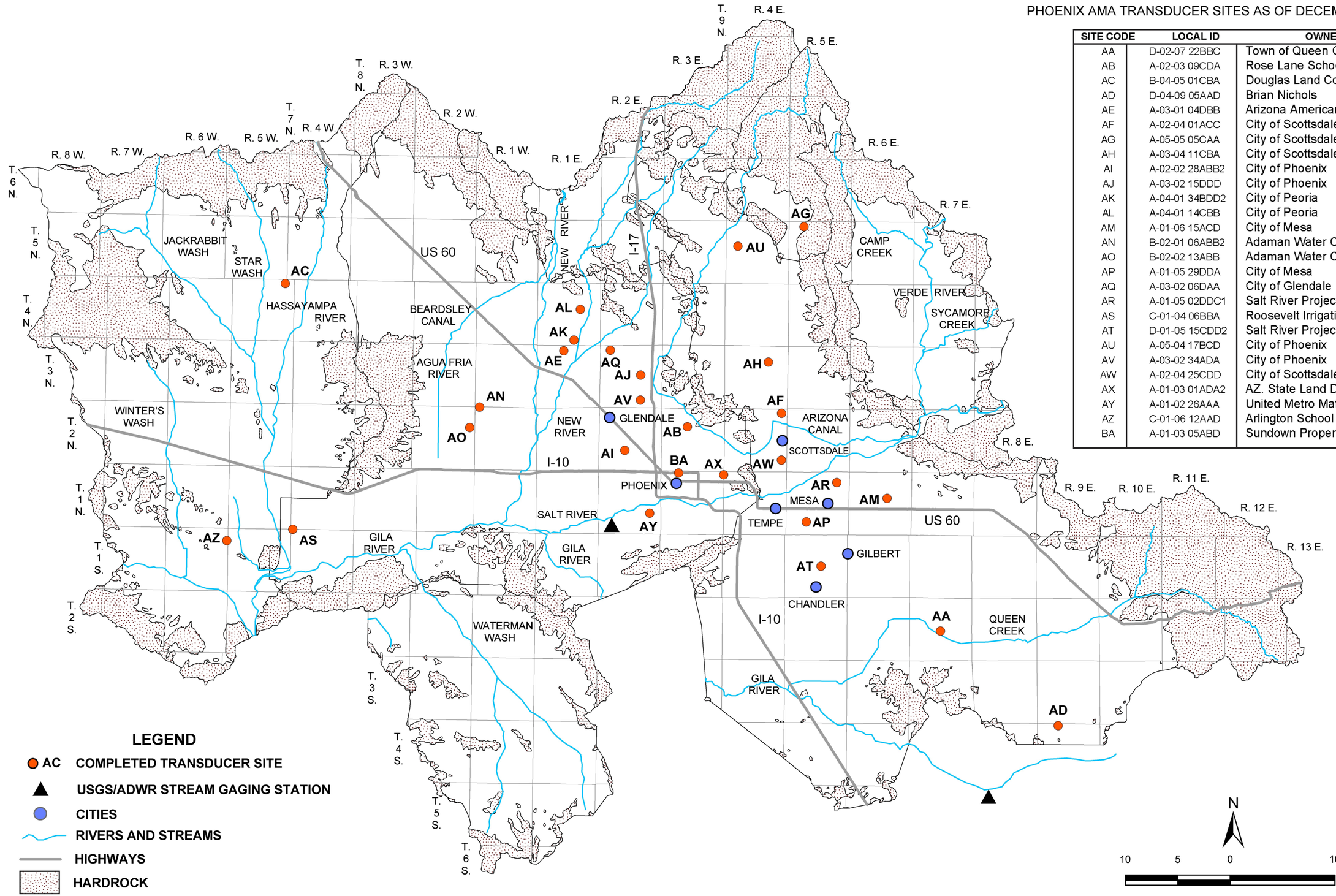
Other well owners will be contacted and added to the above list during the course of the project.

APPENDIX C

MAP PLATES SHOWING TRANSDUCER LOCATIONS AND TRANSDUCER SITE SELECTION CRITERIA

CRITERIA FOR TRANSDUCER SITE SELECTION
PHOENIX AMA TRANSDUCER SITES AS OF DECEMBER 2004

SITE CODE	LOCAL ID	OWNER
AA	D-02-07 22BBC	Town of Queen Creek
AB	A-02-03 09CDA	Rose Lane School
AC	B-04-05 01CBA	Douglas Land Corp.
AD	D-04-09 05AAD	Brian Nichols
AE	A-03-01 04DBB	Arizona American Water
AF	A-02-04 01ACC	City of Scottsdale
AG	A-05-05 05CAA	City of Scottsdale
AH	A-03-04 11CBA	City of Scottsdale
AI	A-02-02 28ABB2	City of Phoenix
AJ	A-03-02 15DDD	City of Phoenix
AK	A-04-01 34BDD2	City of Peoria
AL	A-04-01 14CBB	City of Peoria
AM	A-01-06 15ACD	City of Mesa
AN	B-02-01 06ABB2	Adaman Water Company
AO	B-02-02 13ABB	Adaman Water Company
AP	A-01-05 29DDA	City of Mesa
AQ	A-03-02 06DAA	City of Glendale
AR	A-01-05 02DDC1	Salt River Project
AS	C-01-04 06BBA	Roosevelt Irrigation District
AT	D-01-05 15CDD2	Salt River Project
AU	A-05-04 17BCD	City of Phoenix
AV	A-03-02 34ADA	City of Phoenix
AW	A-02-04 25CDD	City of Scottsdale
AX	A-01-03 01ADA2	AZ. State Land Department
AY	A-01-02 26AAA	United Metro Materials
AZ	C-01-06 12AAD	Arlington School
BA	A-01-03 05ABD	Sundown Properties LTD.



LEGEND

- AC COMPLETED TRANSDUCER SITE
- USGS/ADWR STREAM GAGING STATION
- CITIES
- RIVERS AND STREAMS
- HIGHWAYS
- HARDROCK

N

10 5 0 10
Miles

MAP OF PHOENIX AMA ILLUSTRATING COMPLETED TRANSDUCER SITES AND RIVER AND STREAM COURSES

CRITERIA FOR TRANSDUCER SITE SELECTION

LEGEND

- **AA** — **COMPLETED TRANSDUCER SITE**
- **-19** — **WATER LEVEL CHANGE IN FEET** (Number-19 is the difference in feet between winter 1997 and winter 2002 water- level measurements)
- **CITIES**
- **HIGHWAYS**
- **HARDROCK**

N

10 5 0 10 Miles

MAP OF PHOENIX AMA ILLUSTRATING WATER LEVEL ELEVATION CHANGES (IN FEET) FROM 1997 TO 2002

CRITERIA FOR TRANSDUCER SITE SELECTION

LEGEND

- AC COMPLETED TRANSDUCER SITE
- SUBSIDENCE ZONES
- CITIES
- HIGHWAYS
- HARDROCK

T. 9 N.
T. 8 N.
T. 7 N.
T. 6 N.
T. 5 N.
T. 4 N.
T. 3 N.
T. 2 N.
T. 1 N.
T. 1 S.
T. 2 S.
T. 3 S.
T. 4 S.
T. 5 S.
T. 6 S.

R. 8 W. R. 7 W. R. 6 W. R. 5 W. R. 4 W. R. 3 W. R. 2 W. R. 1 W. R. 1 E. R. 2 E. R. 3 E. R. 4 E. R. 5 E. R. 6 E. R. 7 E. R. 8 E. R. 9 E. R. 10 E. R. 11 E. R. 12 E. R. 13 E.

US 60
I-17
I-10
US 60

AC AG AU AL AK AQ AE AH AJ AV AN AO AF AB SCOTTSDALE AI BA AX AW AR PHOENIX AM MESA AY TEMPE AP GILBERT AT CHANDLER AZ AS AA AD

GLENDALE

N

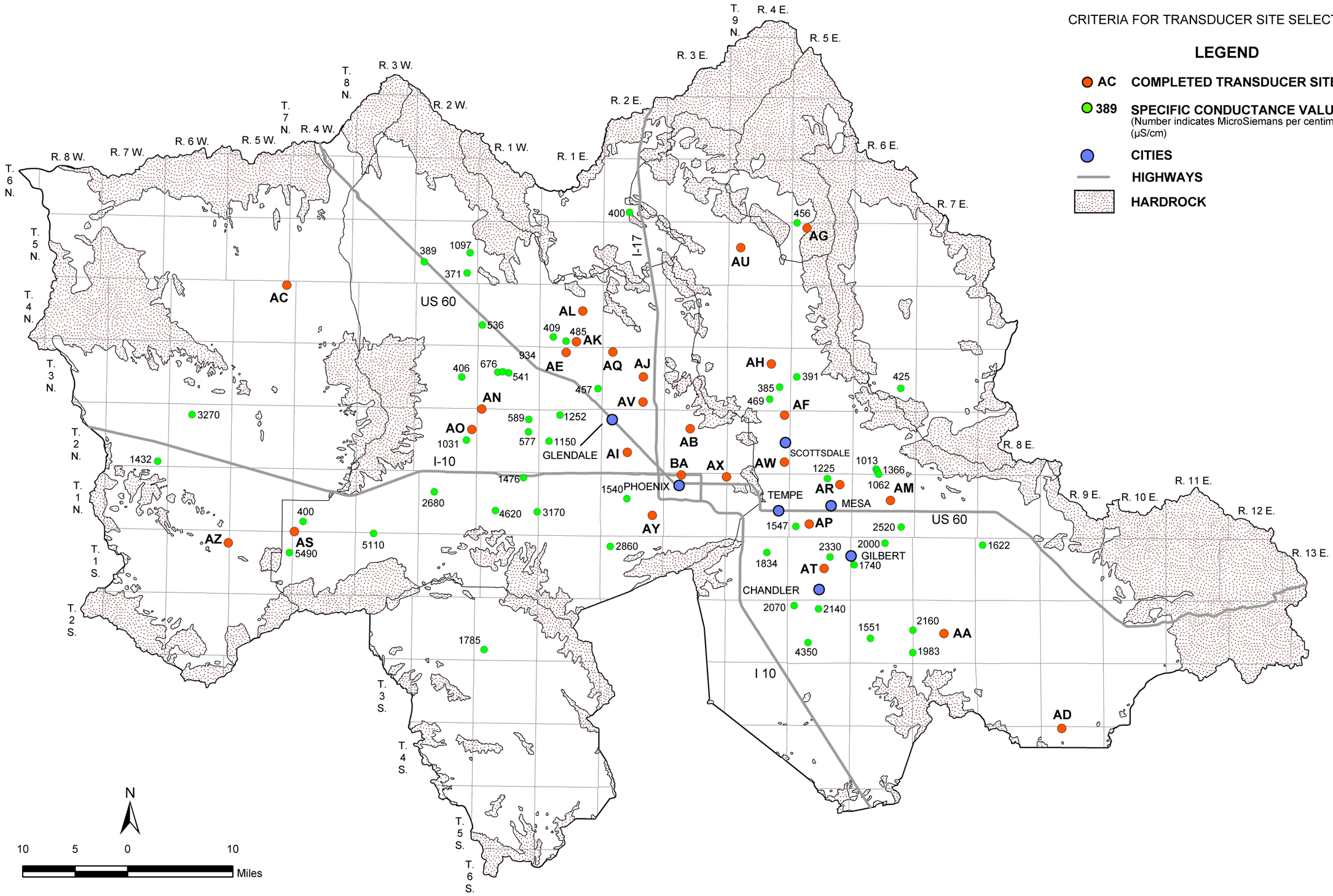
10 5 0 10 Miles

MAP OF PHOENIX AMA ILLUSTRATING SUBSIDENCE ZONES

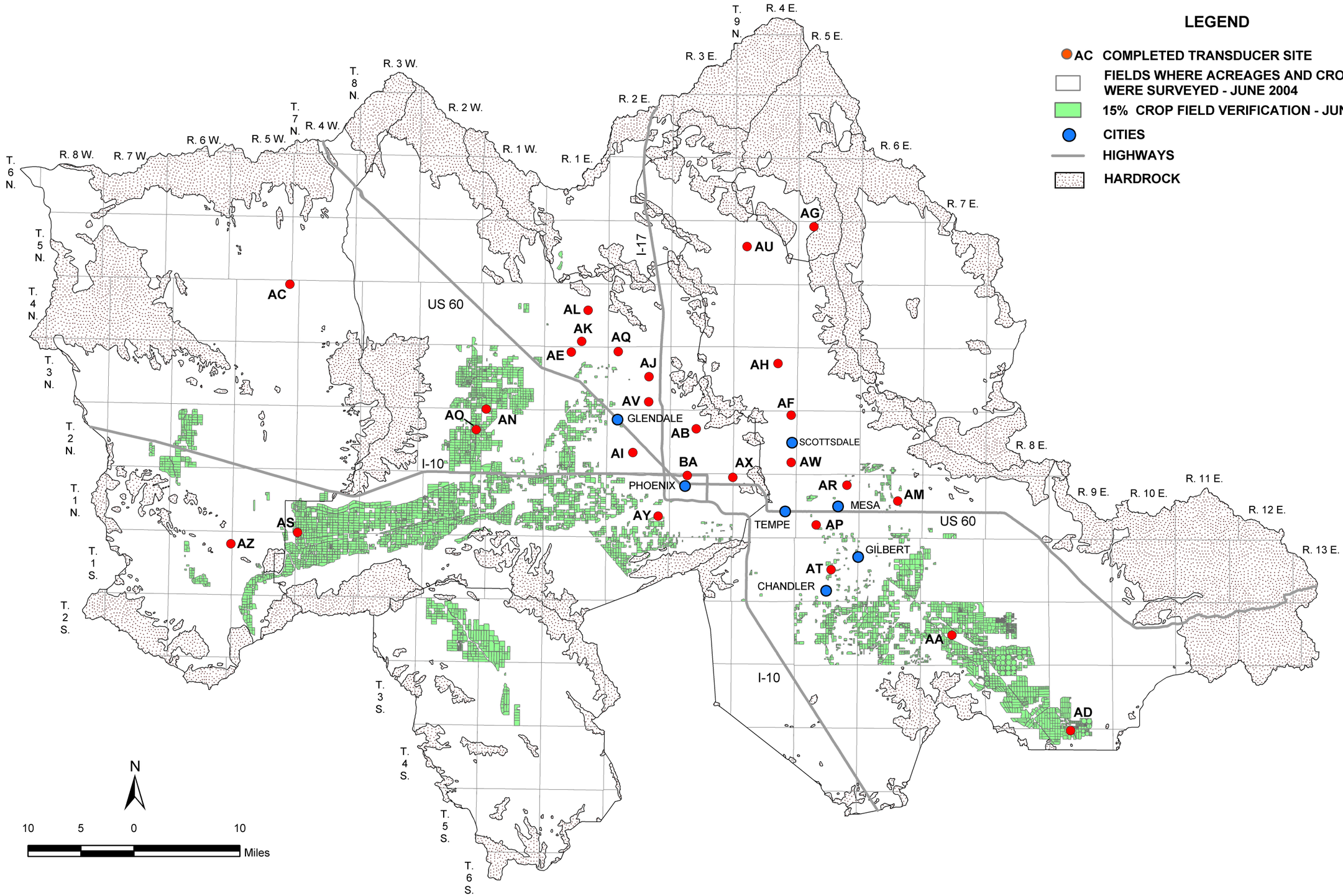
CRITERIA FOR TRANSDUCER SITE SELECTION

LEGEND

- AC — COMPLETED TRANSDUCER SITE
- 389 — SPECIFIC CONDUCTANCE VALUES (Number indicates MicroSiemans per centimeters at 25°c) (µS/cm)
- CITIES
- HIGHWAYS
- HARDROCK



MAP OF PHOENIX AMA ILLUSTRATING SPECIFIC CONDUCTANCE VALUES IN WELLS SAMPLED IN 2004



MAP OF PHOENIX AMA ILLUSTRATING LOCATIONS OF FIELDS WHERE CROPS WERE SURVEYED - JUNE 2004